

This Page Is Inserted by IFW Operations  
and is not a part of the Official Record

## **BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning documents *will not* correct images,  
please do not report the images to the  
Image Problem Mailbox.**



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification <sup>5</sup> :</b>  <b>D06M 15/233</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 92/07131</b>  <b>(43) International Publication Date:</b> 30 April 1992 (30.04.92)
<b>(21) International Application Number:</b> PCT/US91/07351 <b>(22) International Filing Date:</b> 15 October 1991 (15.10.91)  <b>(30) Priority data:</b> 599,284                      18 October 1990 (18.10.90)      US  <b>(71) Applicant:</b> E.I. DU PONT DE NEMOURS AND COMPANY [US/US]; 1007 Market Street, Wilmington, DE 19898 (US).  <b>(72) Inventors:</b> LISS, Theodor, Arthur ; 105 Rockingham Drive, Wilmington, DE 19803 (US). RAO, Nandakumar, Seshagiri ; 112 Brookrun Drive, Hockessin, DE 19707 (US).  <b>(74) Agents:</b> FEENY, Charles, E. et al.; E.I. du Pont de Nemours and Company, Legal/Patent Records Center, 1007 Market Street, Wilmington, DE 19898 (US).		<b>(81) Designated States:</b> AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CA, CF (OAPI patent), CG (OAPI patent), CH (European patent), CI (OAPI patent), CM (OAPI patent), CS, DE (European patent), DK (European patent), ES (European patent), FI, FR (European patent), GA (OAPI patent), GB (European patent), GN (OAPI patent), GR (European patent), HU, IT (European patent), JP, KP, KR, LK, LU (European patent), MC, MG, ML (OAPI patent), MN, MR (OAPI patent), MW, NL (European patent), NO, PL, RO, SD, SE (European patent), SN (OAPI patent), SU <sup>+</sup> , TD (OAPI patent), TG (OAPI patent).  <b>Published</b> <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>
<b>(54) Title:</b> STAIN-RESISTANT SULFONATED AROMATIC POLYMERS  <b>(57) Abstract</b>  Stain-resistant, polyamide textile substrates treated with compositions comprising sulfonated aromatic polymers which contains between about 0.1 and 10 polymer units derived from one or more ethylenically unsaturated aromatic monomers per polymer unit derived from a sulfonated ethylenically unsaturated aromatic monomer, and processes for their preparation. The treated polyamide textile substrates possess stain-resistance but do not suffer from yellowing to the extent that some previously known materials have.		

# + DESIGNATIONS OF "SU"

Any designation of "SU" has effect in the Russian Federation. It is not yet known whether any such designation has effect in other States of the former Soviet Union.

## *FOR THE PURPOSES OF INFORMATION ONLY*

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	ES	Spain	MG	Madagascar
AU	Australia	FI	Finland	ML	Mali
BB	Barbados	FR	France	MN	Mongolia
BE	Belgium	GA	Gabon	MR	Mauritania
BF	Burkina Faso	GB	United Kingdom	MW	Malawi
BG	Bulgaria	GN	Guinea	NL	Netherlands
BJ	Benin	GR	Greece	NO	Norway
BR	Brazil	HU	Hungary	PL	Poland
CA	Canada	IT	Italy	RO	Romania
CF	Central African Republic	JP	Japan	SD	Sudan
CG	Congo	KP	Democratic People's Republic of Korea	SE	Sweden
CH	Switzerland	KR	Republic of Korea	SN	Senegal
CI	Côte d'Ivoire	LI	Liechtenstein	SU+	Soviet Union
CM	Cameroon	LK	Sri Lanka	TD	Chad
CS	Czechoslovakia	LU	Luxembourg	TG	Togo
DE	Germany	MC	Monaco	US	United States of America
DK	Denmark				

- 1 -

TITLE

## STAIN-RESISTANT SULFONATED AROMATIC POLYMERS

FIELD OF THE INVENTION

5           The present invention relates to polyamide textile substrates treated with stain-resistant compositions comprising sulfonated aromatic polymers, and processes for their preparation.

BACKGROUND OF THE INVENTION

10           Polyamide substrates, such as nylon carpeting, upholstery fabric and the like, are subject to staining by a variety of agents, e.g., foods and  
15           beverages. An especially troublesome staining agent is FD&C Red Dye No.40, commonly found in soft drink preparations. Different types of treatments have been proposed to deal with staining problems. For  
20           example, Liss et al., in U.S. Patent Application Serial No. 07/124,866, filed 23 November 1987, disclose stain-resistant synthetic polyamide textile substrates having deposited on them sulfonated phenol/formaldehyde polymeric condensation products. However, sulfonated phenol/formaldehyde condensation  
25           products are themselves subject to discoloration; commonly they turn yellow. W. H. Hemmpel in a March 19, 1982 article in America's Textiles, entitled Reversible Yellowing Not Finisher's Fault, attributes yellowing to exposure of a phenol-based finish to  
30           nitrogen oxides and/or ultra-violet radiation. To deal with the yellowing problem, the condensation products disclosed in the Liss et al. application have been modified by acylation or etherification of some of the phenolic hydroxyls. In a preferred embodiment,  
35           Liss et al. dissolve the modified condensation

- 2 -

products in a hydroxy-containing solvent, such as ethylene glycol, prior to their being applied to the textile substrate. On the other hand, in U.S. Patent 4,833,009, Marshall discloses removing color-forming materials from sulfonated phenol/formaldehyde condensates by acidifying the condensate, applying heat, removing the resulting water-soluble phase and dissolving the insoluble phase in aqueous base prior to applying it to the textile substrate to make it stain-resistant. In yet another approach, Fitzgerald et al., in European Patent Application No. 0329899 published 30 August 1989, disclose hydrolyzed vinyl-aromatic/maleic anhydride polymers having a number average molecular weight between about 500 and 4000 as stain-resist agents, and polyamide textile substrates treated with those polymers. R.A. Weiss et. al. disclose in the Journal of Polymer Science, Polymer Chemistry Edition, Vol 23, 525-533 and 549-568 (1985) that whereas sulfonated ionomers (polymers containing active groups such as sulfonic acid groups) had been prepared previously by sulfonation of the corresponding homopolymers, they had prepared copolymers of styrene and sodium styrene sulfonate by emulsion polymerization. Molecular weights obtained were assumed to be high and similar to the molecular weights of the polymers formed by sulfonation of the homopolymers; e.g.  $M_n$  of 23,000 & 106,000.)

#### BRIEF SUMMARY OF THE INVENTION

The present invention provides polyamide textile substrates treated with sulfonated aromatic polymers so as to impart stain-resistance to the substrates, and methods for preparing the same. The treated polyamide textile substrates possess stain-

- 3 -

resistance but do not suffer from yellowing to the extent that some previously known materials have.

#### DETAILED DESCRIPTION OF THE INVENTION

5           The sulfonated polymers suitable for the purposes of this invention contain between about 0.1 and 10 polymer units derived from one or more ethylenically unsaturated aromatic monomers per polymer unit derived from a sulfonated ethylenically  
10           unsaturated aromatic monomer. Polymers containing about 0.9 polymer unit derived from one or more ethylenically unsaturated aromatic monomers per polymer unit derived from a sulfonated ethylenically unsaturated aromatic monomer are most effective in  
15           imparting stain-resistance to textile substrates.

          A variety of aromatic monomers can be used for the purposes of this invention, e.g., styrene, alpha-methylstyrene, 4-methylstyrene, 4-methoxystyrene, vinylbenzene-4-carboxylic acid, and the like,  
20           and mixtures of the same, with styrene being preferred. Likewise, there are various sulfonated monomers which can be used for the purpose of this invention. The sulfonated monomers usually are water-soluble; for example, the alkali metal and  
25           ammonium salts. Particular examples include sodium p-styrene sulfonate, sodium vinyl p-toluene sulfonate, ammonium p-styrene sulfonate. In addition, the foregoing ethylenically unsaturated aromatics can be sulfonated at the para and/or ortho positions and be  
30           used for the purposes of this invention. An acrylic monomer can be added to either of the above-described two classes of monomers to give a terpolymer having useful dyeing properties, e.g. methacrylic acid, acrylic acid, itaconic acid, their lower alkyl esters  
35           and the like.

- 4 -

The sulfonated polymers of this invention should have number average molecular weights in the range between about 500 and 7000, preferably between about 500 and 5000, most preferably 900 to 3000.

5 They are readily soluble, even at high concentrations, in water at 25-90°C and a pH of 2 or above; increasing dilution is needed at pHs below 2. They are also soluble in lower alcohols, such as methanol, ethylene glycol, propylene glycol, mixtures of ethylene and  
10 hexylene glycols, and are somewhat soluble in acetic acid.

The polymers suitable for the purposes of this invention can be conveniently prepared by a variety of free radical-initiated polymerization  
15 reactions using methods known to the art for limiting the molecular weight of the products. One example is the benzoyl peroxide-initiated polymerization of styrene and sodium styrene sulfonate. Molecular weight control can be accomplished by the use of large  
20 quantities of benzoyl peroxide, in the order of 10%, based on weight of monomers. Alternatively, chain transfer agents such as dodecyl mercaptan may be used with lesser amounts of benzoyl peroxide. Another preparative method is the solution polymerization of  
25 the monomers using Vazo® 67 2,2'-azobis(2-methylbutyronitrile) as an initiator and mercaptosuccinic acid as a chain transfer agent. In all of these methods, a convenient range of monomers plus initiator concentrations in the solvent is about 20 to 35%.

30 The sulfonated aromatic polymers of this invention not only cover the surface of the treated substrate, but particularly in the case of a fibrous substrate, the polymer at least in part permeates the fiber. The polymers can be used as such in treating  
35 polyamide textile substrates. They can be applied to

- 5 -

dyed or undyed polyamide textile substrates. They can be applied to such substrates in the absence or presence of a polyfluoroorganic oil-, water-, and/or soil-repellent materials. In the alternative, such a

5 polyfluoroorganic material can be applied to the textile substrate before or after application of the sulfonated polymers of this invention thereto. The sulfonated polymers can be applied to textile substrates in a variety of ways, e.g. during

10 conventional beck and continuous dyeing procedures. The quantities of the polymers of this invention which are applied to the textile substrate are amounts effective in imparting stain-resistance to the substrate. The amounts can be varied widely; in

15 general, one can use between 0.5 and 5% by weight of them based on the weight of the textile substrate, usually 2% by weight or less. The polymers can be applied, as is common in the art, at pHs ranging between 4 and 5. However, more effective exhaust

20 deposition can be obtained at a pH as low as 2. When pH of 2 is used, the preferred level of application to the textile substrate is about 1.2% by weight of polymer, based on the weight of the textile substrate. More effective stainblocking is obtained if the

25 sulfonated polymers are applied to the textile substrate at higher temperatures. For example, at pH 2, 170°F is preferred. However, stain-resistance can be obtained at room temperature, or even at the temperature of cold tap water (10-15°C), if higher

30 levels of stainblockers are employed. The sulfonated polymers of this invention can also be applied in-place to polyamide carpeting which has already been installed in a dwelling place, office or other locale. They can be applied as a simple aqueous preparation or

35 in the form of aqueous shampoo preparation, with or



- 6 -

without one or more polyfluoro-organic oil-, water-, and/or soil-repellent materials. They may be applied at the levels described above, at temperatures described, and at a pH between about 1 and 12, preferably between about 2 and 9.

The following Examples are illustrative of the invention. Unless otherwise indicated, all parts and percentages are by weight and temperatures in the Examples and Tests are in degrees Celsius. In the examples that follow, stain-resistance and yellowing were measured by the techniques described below. Number average molecular weights are usually determined by vapor-phase osmometry. However, that method cannot be applied to compositions of this invention because of the presence of glycols and other interfering lower molecular weight substances. In Example 1, number average molecular weights were approximated by gel permeation chromatography. On the other hand, gel permeation chromatography determinations are difficult to run; consequently, no molecular weight determinations were made for the compositions of Examples 2-7.

Exhaust Application of Stain-Resists to Carpeting  
Launder-O-Meter Method

Exhaust application of stain-resists to carpeting is carried out in a Launder-O-Meter automated dyeing machine. One carpet piece is contained in each of several (up to twenty) stainless steel, screw-cap canisters. The canisters are held in a rack that rotates in a water bath whose temperature is automatically controlled for rate of heating, time at temperature and cooling. For a typical application bath, one uses a 20 to 1 liquor to goods ratio with 2.5 weight % of the stain-resistant composition. The

- 7 -

stain-resistant compositions can be applied at pH 2 or pH 5. At pH 2, an excess of sulfamic acid is used. At pH 5, an excess of ammonium sulfate is used, as well as 3g/L of magnesium sulfate and 1g/L of an alkyl aryl sulfonate (Alkanol®ND) or a suitable leveling agent. After the bath is made up, a solution of the stain-resist composition is added to the Launder-o-Meter canister. The carpet sample to be treated is then placed in the canister, tufted side out, the size of the carpet sample, relative to the size of the canister, being such that no portion of the sample touches another portion of the sample. The canisters are placed in the Launder-O-Meter and the water bath temperature is held at 110°F for 5 minutes. The temperature of the water bath is then raised to the desired temperature for application of the stain-resist composition. For application at pH 2, the temperature of the water bath is raised to 170°F +/- 5°F, and for application at pH 5, the temperature of the water bath is raised to 200°F +/- 5°F. After the bath water reaches the desired temperature, it is held there for 20 min. and then cooled to 100°F. The treated carpet sample is removed from the canister and rinsed by squeezing in deionized water at room temperature. Three successive rinses in fresh deionized water are given, each rinse being at 40 volumes of water per volume of sample. The rinsed carpet sample is centrifuged to remove excess liquid and dried at 200°F. in a forced draft oven for 30 minutes. The dry carpet sample can then be tested by use of the tests described below.

#### Stain Test

The stain test is used to measure the extent to which carpeting is stained by a commercial beverage

- 8 -

composition which contains FD&C Red Dye No. 40 (an acid dye). The staining liquid, if sold commercially as a liquid, is used as is. Usually the commercial product is in the form of a solid. In that event, the beverage preparation, in dry, solid form, is dissolved in deionized water so as to provide 0.1 g of FD&C Red Dye No. 40 per liter of water. Sufficient wetting agent (Du Pont Merpol®SE liquid nonionic ethylene oxide condensate) is added to the dye solution to provide 0.5 g of the wetting agent per liter of dye solution. Unless otherwise specified, the test sample is DuPont type 1150 Nylon 6,6 (white); Superba heatset, mock dyed level loop carpet, 3/8 inch pile height, 30 ounces per yard, 1/10 inch gauge, 10 stitches per inch, woven polypropylene primary backing. The test sample is wetted completely with water, and excess water is removed by centrifuging. The damp sample is placed tufted face down in a pan and covered with ten times its face weight of stain fluid. Entrained air is expelled from the sample by squeezing or pressing. The sample is turned over and again the air is expelled. The sample is then returned to a face down position, and the pan is covered for storage for test period of 30 minutes. The stored stain sample is rinsed in running cool water until no more stain is visually detectable in the rinse water. The rinsed sample is extracted in a centrifuge and dried at 200 degrees F. Staining is evaluated with the Minolta Chroma Meter tristimulus color analyzer in the L\*A\*B Difference Mode with the target sample set for the unstained carpet. The "a" value is a measure of redness, with a value of 43 equal to that obtained on an untreated carpet. The stain-resistance of the resulting carpet sample is visually determined by the amount of color left in

- 9 -

the stained area of the carpet sample according to the following scale:

- 5                    5 = no staining  
                    4 = slight staining  
                    3 = noticeable staining  
                    2 = considerable staining  
                    1 = heavy staining.

#### UV YELLOWING TEST

10                    The light-fastness of carpet samples treated  
with a stainblocker is determined by exposing the  
treated samples to UV light for 20 Hours. A sample  
piece of carpet that has been treated with a  
stain-blocker is placed in a box containing its hinged  
15 top a standard fluorescent fixture fitted with two  
forty watt lamps. Centered under the pair of lamps in  
the bottom of the box is a sliding tray having a 3  
inch x 40 inch recess for holding carpet specimens.  
The depth of the recess is such that the distance from  
20 the carpet face to the plane defined by the lamp  
surfaces is 1 inch. The current to the lamp is  
controlled by a timer so that a twenty-hour exposure  
can be obtained automatically. After the twenty-hour  
exposure, the reflectance of CIE White Light Source C  
25 from the carpet is compared with the reflectance from  
an unexposed sample and the CIELAB delta "b" noted.  
Delta "b" is a measure of the yellow component of  
white light. A Minolta Chroma Meter model CR-110  
reflectance meter is used to make the measurements and  
30 to calculate delta "b" automatically from stored data  
on the unexposed sample. The value of "b" is reported  
as the measure of yellowing with increasing positive  
values of "b" corresponding to increased degrees of  
yellowing.

35

- 10 -

The Minolta Chroma Meter is used in the Hunter L\*a\*b color-deviation measuring mode [Richard Hunter, "Photoelectric Colorimetry with Three Filters," J. Opt. Soc. Am., 32, 509-538 (1942)]. In the measuring mode, the instrument measures the color differences between a "target" color, whose tristimulus color values have been entered into the microprocessor as a reference, and the sample color presented to the measuring head of the instrument. In examining carpet samples for yellowing and for FD&C Red Dye No. 40 staining, the "target" color entered is that of the carpet before yellowing or staining. The color reflectance of the yellowed or stained carpet is then measured with the instrument and reported as:

\*E, the total color difference, \*L, the lightness value,  
\*a, the redness value, if positive, or greenness, if negative, and  
\*b, the yellowness value, if positive, or blueness, if negative.

#### Example 1

Ethylene glycol, 800 g, was added to a 2 liter flask, heated to 70°C with a nitrogen sparge and held at that temperature for 1 hour. It was cooled to 25°C and sodium styrene sulfonate, 150 g (0.73 mol), was added with agitation in about 5 minutes. Agitation was continued until a solution was obtained, about 45 minutes. A solution of styrene, 50 g (0.48 mol), in hexylene glycol, 200 g, was added over 15 minutes, and the reaction mixture was allowed to warm to 65-70°. Benzoyl peroxide, 40.0 g (0.165 mol), was added in 3 portions, each portion 1/2 hour apart. The temperature was allowed to rise to about 85° during these additions. The mass was maintained

- 11 -

at 80° for 8 hours. A yellow to amber solution of the polymer was obtained, solids = 19%, residual monomer 1%, and molecular weight ranging from 800 to 7000 by gel permeation chromatography.

5

#### Example 2

Example 1 was repeated with 91.8 g (0.44 mol), of sodium styrene sulfonate and 108.6 (1.04 mol), of styrene. The reaction proceeded in fashion similar to that of Example 1.

10

#### Example 3

Ethylene glycol, 98.0 g, was added to a 250 ml flask and heated to 70° with a nitrogen sparge and held at that temperature with agitation for 1 hour. It was cooled to 25° and sodium styrene sulfonate, 8.3 g (0.04 mol), and itaconic acid, 5.2 g (0.04 mol), was added with agitation in about 5 minutes. Agitation was continued until solution was complete, about 30 minutes. A solution of styrene, 6.3 g (0.06 mol), in hexylene glycol, 25 g, was added over 15 minutes and the mixture was allowed to heat to 65-70°. Benzoyl peroxide, 4.8 g (0.02 mol), was added in one portion. A 6° heat rise was noted. The mass was maintained at 80° for 8 hours. An amber solution of polymer was obtained, solids = 13%.

15

20

25

#### Example 4

A mixture of ethylene glycol, 170 g, and hexylene glycol, 43 g, was heated with a nitrogen sparge and agitation to 70° and held for 1 hour. It was cooled to 25°. Vinylbenzene-4-carboxylic acid, 29.6 g (0.2 mol), and sodium styrene sulfonate, 30.9 g (0.15 mol), were added to the solvent mixture to yield a clear solution. The mass was heated to 70° and

30

35

- 12 -

benzoyl peroxide, 23.2 g (0.1 mol), was added. A 6° heat rise was observed. The reaction mass was held at 80° for 8 hours. A clear yellow polymer solution was obtained, solids = 18.7%.

5

Example 5

Example 4 was repeated using vinylbenzyl chloride, 22.9 g (0.2 mol), instead of the vinyl-benzyl-4-carboxylic acid. A dark brown polymer solution was obtained, solids = 17.9%.

10

Example 6

Ethylene glycol, 73 g, was heated to 70° with a nitrogen sparge and held at that temperature for 1 hour with agitation. It was cooled to 25° and sodium styrene sulfonate, 40.6 g (0.2 mol), and dodecyl mercaptan, 3.6 g (0.016 mol), were added. A solution of styrene, 31.5 g (0.3 mol), in hexylene glycol, 73 g, was added over 5 minutes and the reaction mixture was allowed to warm to 65-70°. Benzoyl peroxide, 230 g (0.095 mol), was added in one portion. A 6° heat rise was noted. The mass was held at 80° for 8 hours. A clear yellow viscous solution of polymer was obtained, solids = 38%.

15

20

25

30

35

- 13 -

TABLE 1

		<u>Example</u>					
		1	2	3	4	5	6
5	Initial						
	Discoloration	2.4	2.3	2.3	2.6	3.5	1.7
	Staining	7.1	8.7	6.2	12.7	14.8	3.1
	UV yellowing	1.0	1.0	1.3	1.6	2.3	1.2

10

Example 7

Sodium styrene sulfonate, 37.5 g (0.18 mol), in 200 g of acetic acid was heated to 70° with agitation under nitrogen at atmospheric pressure.

15 Sufficient water, 38.0 mls., to dissolve the sodium styrene sulfonate was added. There were then added in turn a solution of 12.5 g (0.12 mol) of styrene in 50 g of acetic acid, 7.5 g (0.05 mol) of mercapto-succinic acid and 9.1 g (0.05 mol) of Vazo® 67

20 [2,2'-azobis-(2-methylbutyronitrile)]. The temperature was raised to 80° and the mass was held overnight at 80° to yield a pale yellow product solution.

Nylon film treated with a solution of this

25 product showed no staining with FD&C Red Dye No. 40.

30

35



- 14 -

CLAIMS

1. A polyamide textile substrate treated with an effective amount of a composition capable of imparting stain-resistance to it comprising a sulfonated aromatic polymer having a number average molecular weight in the range of between about 500 and 7000 which contains between about 0.1 and 10 polymer units derived from one or more ethylenically unsaturated aromatic monomers per polymer unit derived from a sulfonated ethylenically unsaturated aromatic monomer.

2. The polyamide substrate of Claim 1 wherein said polymer contains between about 0.9 and about 3 polymer units derived from one or more ethylenically unsaturated aromatic monomers per polymer unit derived from a sulfonated ethylenically unsaturated aromatic monomer.

3. The polyamide substrate of Claim 2 wherein said ethylenically unsaturated aromatic monomer is styrene, alpha-methyl-styrene, 4-methyl-styrene, or 4-methoxystyrene, vinylbenzene-4-carboxylic acid, or mixtures of the same.

4. The polyamide substrate of Claim 3 wherein said ethylenically unsaturated aromatic monomer is styrene.

5. The polyamide substrate of Claim 2 wherein said sulfonated ethylenically unsaturated aromatic monomer is sodium styrene sulfonate.

- 15 -

6. The polyamide substrate of Claim 1 wherein said sulfonated aromatic polymer has a molecular weight (number average) in the range between about 500 and 5,000.

5

7. The polyamide substrate of Claim 6 wherein said sulfonated aromatic polymer has a molecular weight (number average) in the range between about 900 and 3,000.

10

8. A process for imparting stain-resistance to a textile substrate which comprises applying to said substrate an effective amount of a composition comprising a sulfonated aromatic polymer having a number average molecular weight in the range between about 500 and 7000 which contains between about 0.1 and 9 polymer units derived from one or more ethylenically unsaturated aromatic monomers per polymer unit derived from a sulfonated ethylenically unsaturated aromatic monomer.

20

9. The process of Claim 8 wherein said sulfonated aromatic monomer contains between about 0.4 and 3 polymer units derived from one or more ethylenically unsaturated aromatic monomers per polymer unit derived from a sulfonated ethylenically unsaturated aromatic monomer.

25

10. The process of Claim 9 wherein said ethylenically unsaturated aromatic monomer is styrene, alpha-methylstyrene, 4-methylstyrene, or 4-methoxystyrene, vinylbenzene-4-carboxylic acid, or mixtures of the same.

30

35

- 16 -

11. The process of Claim 10 wherein said ethylenically unsaturated aromatic monomer is styrene.

5 12. The process of Claim 11 wherein said sulfonated ethylenically unsaturated aromatic monomer is sodium styrene sulfonate or sodium vinyltoluene sulfonate.

10 13. The process of Claim 8 wherein said sulfonated aromatic polymer has a molecular weight (number average) in the range between about 500 and 5,000.

15 14. The process of Claim 13 wherein said sulfonated aromatic polymer has a molecular weight (number average) in the range between about 900 and 3,000.

20

25


30

35

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 91/07351

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (If several classification symbols apply, indicate all) <sup>6</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int.Cl. 5 D06M15/233		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>7</sup>		
Classification System	Classification Symbols	
Int.Cl. 5	D06M ; D06P	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>8</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup></b>		
Category <sup>10</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
X	FR,A,1 443 521 (HOECHST AG.) 16 May 1966 see claims; example 3 ---	1-14
X	EP,A,0 333 500 (ALLIED COLLOIDS LIMITED) 20 September 1989 see page 3, line 35 - line 38; claims; example 3 ---	1-14
A	US,A,2 700 001 (COHEN ET AL.) 18 January 1955 see the whole document ---	1-14
A	EP,A,0 329 899 (E.I. DU PONT DE NEMOURS AND COMPANY) 30 August 1989 cited in the application see the whole document ---	1-14
E	EP,A,0 456 390 (ALLIED COLLOIDS LIMITED) 13 November 1991 see the whole document ---	1-14
<p><sup>10</sup> Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"A" document member of the same patent family</p>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
13 MARCH 1992	19. 03. 92	
International Searching Authority	Signature of Authorized Officer	
EUROPEAN PATENT OFFICE	BLAS V. 	

**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
ON INTERNATIONAL PATENT APPLICATION NO. US 9107351  
SA 53722**

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.  
The members are as contained in the European Patent Office EDP file on  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information. 13/03/92

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR-A-1443521		BE-A- 666265	03-01-66
		CH-B- 479753	15-10-69
		CH-A- 907765	
		DE-A- 1469350	19-12-68
		GB-A- 1106212	
-----			
EP-A-0333500	20-09-89	None	
-----			
US-A-2700001		None	
-----			
EP-A-0329899	30-08-89	AU-A- 2708988	15-06-89
		JP-A- 2138365	28-05-90
		US-A- 5001004	19-03-91
-----			
EP-A-0456390	13-11-91	None	
-----			

EPO FORM P007

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82